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EDUCATIONAL AND TOURISM USE OF EASY-ACCESS VIEWPOINTS: A STUDY IN THE ITATIAIA NATIONAL PARK, BRAZIL

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Abstract— The inventory of the geological heritage of the Itatiaia National Park, Brazil is being developed based on scientific, educational and tourism criteria. Among the sites of geological interest already selected, the Último Adeus and the Rodovia das Flores viewpoints stand out because of their easy access, viewpoint typology and suitability for interpretative and educational purposes. This work presents qualitative and quantitative assessments of scientific value, potential educational and tourism uses and degradation risk of these sites. The quantitative assessment was carried out using the GEOSSIT platform, which was developed by the Geological Survey of Brazil (CPRM). According to the numerical evaluation, the Último Adeus viewpoint (classified as geosite) achieved the highest values regarding educational and tourism uses, a result that reinforces its current use for tourism activities. The Rodovia das Flores viewpoint (classified as geodiversity site) obtained the lowest value regarding degradation risk. The data indicate that both sites are quite suitable to be used in educational projects due to high educational and tourism potentials and low degradation risk. Measures to enhance both formal and non-formal education were suggested and involve the development and inclusion of geoscientific information in leaflets, digital media, interpretative panels, interpretative centre, road sign, geotouristic guidebooks and complementary courses on geosciences. Such measures may contribute to the interpretation, promotion, dissemination and conservation of the geodiversity elements in sites of geological interest and in the whole protected area.

Keywords— Accessibility, geoconservation strategies, geodiversity, protected areas, quantitative assessment, viewpoint geosites.

Thematic line— Geoconservation, Geotourism and Geoheritage.

1 Introduction

Geoconservation arose aiming to avoid that the sites with geoscientific importance be destroyed in Sharples (2002), Gray (2004) and Gray (2013). Based on this fact, Brilha (2005, 2016) elaborated a method that consists of a series of steps aimed the conservation of the abiotic elements. This author points out that the sites presenting threats must be submitted to the geoconservation strategies.

The insertion of inventoried geosites into processes of territorial planning, protected areas management, and tourism and educational activities contributes to geoheritage conservation. For Rodrigues (2013) after the conservation of the geosites, interpretation action should be one of the main priorities in locals which aim to work for raising awareness the general public. For this reason, the evaluation of geoheritage is important to recognize, disseminate and define the sites that should be used in the promotion of geodiversity to the general public. These evaluations enable defining their use and management plans regarding the specificity of each site.

According to Henriques et al. (2011) a geosite that illustrates geological aspects for using in the educational system (from elementary school to university), has the good quality of the exposure and easy accessibility, it turns out to be an excellent educational resource.

The sites of geological interest with easy access present advantages regarding the others, because they may be utilized to demonstrate the geoconservation importance, promote and disseminate the geosciences contents for any audience (including children, people with disabilities and elderly people).

According to Amorfini et al. (2015), the first attempt to turn an accessible geosite for tourists in Apuan Alps

Geopark was made in 1964 (the Equi Terme Cave). Since then, this Geopark has been investing in tourism facilities, allowing the use of geosites for any public, among these actions, stands out the Serenaia Valley trail, which was specially adapted to people with disabilities.

Other examples of accessible geosites for any public are observed on the inclusive programmes in UNESCO Global Geoparks (UGG): i) interpretative facilities for blind people: interpretative panels in Braille (Molina & Alto Tajo UGG, Spain), tactile models (Cabo de Gata-Níjar UGG, Spain), books for children written in Braille (Naturtejo UGG, Portugal), and outdoor educational activities (Araripe UGG, Brazil); ii) accessible sites to people in wheelchairs or physical disabilities: Molina & Alto Tajo UGG (Spain), Burren & Cliffs of Moher UGG (Ireland), and Cabo de Gata-Níjar UGG (Spain), and iii) programme to test the accessibility of sites in order to allow visits of adults with intellectual disabilities were being developed in Burren & Cliffs of Moher UGG, Ireland in Canesin et al. (2017).

Further to sites of geological interest that presented easy access, the viewpoint geosites also are excellent places to disseminate the geosciences contents. As recently indicated by Migón and Pijet-Migón (2017), viewpoint geosites are locations that allow unobstructed observation of the surrounding landscape and comprehension of Earth history recorded in rocks, structures and landforms visible from this locality. Thereby, viewpoint geosites are particularly suitable places to developing for landscape interpretation due to their panorama view.

According to Fuertes-Gutiérrez and Fernández-Martínez (2010), the geosites may be classified in few typologies, among them, viewpoint stands out for including two different elements: i) a large area of geological interest; ii)

an observatory from where this area may be viewed. In relation to natural threats, neither of elements are fragile themselves; the area because of its large dimensions and the observatory due to its site's far external location. In spite of that, the vulnerability (human threats) may be high because the panoramic quality of the view may be injured for any activity that causes a visual impact. Regarding potential use, viewpoint typology presents a peculiar management because they can afford high pressures as the interest of geosites are at a distance; moreover, they are good sites for geoscientific popularization.

Among the proposals for geosciences dissemination to formal and non-formal education, we could quote the actions for geodiversity interpretation and education that have been developing in Brazil: i) interpretative panels developed by the Geological Paths Project of the State of Rio de Janeiro, Geological and Paleontological Sites Project of the State of Paraná, Geological Paths Project of the State of Bahia, Geological Monuments of the State of Rio Grande do Norte, and Geological Monuments of the State of São Paulo in Mansur (2009), as well as geotourism route on the northern coast of the State of São Paulo in Mazoca et al. (2017); ii) Geology education projects formulate by Geological Paths of the State of Rio de Janeiro, Geological and Paleontological Sites of the State of Paraná in Mansur (2009) and for teachers and environmental monitors in Garcia et al. (2016) and Mazzucato, (2017); iii) science dissemination at museums and science centre; iv) road sign installed by Geological Paths and Darwin's Paths, both in State of Rio de Janeiro; and v) leaflets distributed by several institutions.

In fact, geosites that possess easy access and viewpoint typology of which represent the perfect combination for being used in geosciences dissemination proposals in both formal and non-formal education.

Based on these facts, this work aims to discuss the results of qualitative and quantitative assessments of the scientific value, potential educational and tourism uses and degradation risk of two viewpoint sites that possess the easiest access of the Itatiaia National Park. From the results were made proposals for the valorization and interpretation of sites of geological interest aiming to increase the geoscientific concepts dissemination to formal and non-formal education purposes.

2 Characterization of the study area

The Itatiaia National Park (INP) was the first protected area founded in Brazil in 1937 (Federal Decree nº 1.713), initially with a territorial area of 11.943 hectares. By 1982, the decree number 87.586 extended its surface to approximately 30.000 hectares. It comprehends part of the municipalities of Itatiaia and Resende, in State of Rio de Janeiro, and Itamonte and Bocaina de Minas, in the State of Minas Gerais (Fig. 1).

The INP constitutes an integrally protected area as regulated by the Brazilian National System of Protected Areas (law nº 9.985/2000). Among the various classifications for integral protection, there is the national park, which aims the preservation of natural ecosystems, devel-

opment of scientific surveys and education and environmental interpretation activities, and ecological tourism according to Brazil (2000).

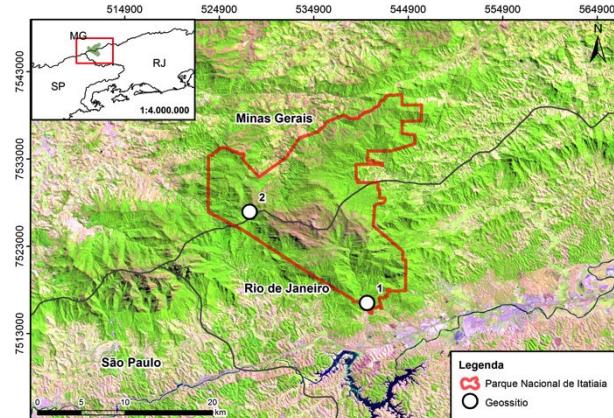


Figure 1. Location map of the Itatiaia National Park with the sites of geological interest studied in this work: 1. Geosite Último Adeus viewpoint and 2. Geodiversity site Rodovia das Flores viewpoint

The study area is drained by Grande and Paraíba do Sul Rivers' basins according to ICMBIO (2013). According to Köppen-Geiger climate classification, this protected area has two climates: i) mesothermic, with mild summer and rainy season in summer; ii) mesothermic, with mild summer without dry seasons in IBDF (1982).

Despite INP is located between the two biggest Brazilian metropolises (São Paulo and Rio de Janeiro), it is integrally inserted in the Mata Atlântica biome. It composes the Mantiqueira Mountain Range protected areas mosaic, which aims to conserve both natural and cultural heritage of the seventeen protected areas of this region.

For administrative reasons, the park area is divided into three areas: i) lower part; ii) upper part; and iii) Visconde de Mauá in Tomzhinski (2012). From a geology point of view, the main geological frameworks present in the Park belongs to rocks: i) granites and gneisses of Precambrian ages; ii) intrusive alkaline rocks of Mesozoic ages; and iii) unconsolidated deposits of Cenozoic age. The geomorphological setting of the region is related with the uplift caused for the taphrogenic tectonics, which resulted in the horsts of Serra do Mar and Mantiqueira separated by the graben of Paraíba do Sul according to Neto et al. (2015). In relation to geomorphological aspects, the study area includes the formations of the Mantiqueira Mountain Range and Paraíba do Sul in ICMBIO (2013).

3 Qualitative assessment of the inventory of sites of geological interest

3.1 Method

The inventory of geoheritage of the Itatiaia National Park is being developed based on scientific, educational and tourism criteria.

The selection of potential sites of geological interest was based in the method described by Mucivuna & Garcia (2017), which comprehends the following steps: i) literature review; ii) analysis of the protected area management

plan and research bulletins; iii) review of touristic advertisement materials; iv) interviews with researchers who conduct geosciences research in the area; v) analysis of geological and geomorphological maps, topographical charts and satellite images; vi) list of potential sites; vii) analysis of access routes and pathways; viii) field trip for qualitative assessment, description and identification of the new sites; ix) final list of sites with complete characterization.

Based on these steps were selected 72 potential sites of geological interest. Until the moment, 38 were evaluated at field trips, of which 20 were included for the final list. In general, the selected sites have difficult access and they are reached only through long trails with the high-level of difficulty; this fact contributes to limited access to geological knowledge of the region. Despite access hampered mainly for terrain declivity, two sites of geological interest stand out due to easy access (Último Adeus and Rodovia das Flores viewpoints). The access to both sites is not made by trails and they are located on a road with access by cars. In this way, these places may be utilized by anyone because the sites have not obstacles to access. Due to their characteristics, these sites were evaluated in relation to the scientific value, potential of educational and tourism uses and degradation risk to support proposals for use in these sites of geological interest.

3.2 Characterization of the easy access geosites

Último Adeus viewpoint

This site is situated on lower part of the National Park (UTM coordinates 23 K 540414 / 7516328) with 812 meters high. The access is made by BR-485 highway in direction to the head office (Fig. 1).

It corresponds to a viewpoint with a panoramic view of the Mantiqueira and Bocaina Mountain Ranges, and Rio Paraíba do Sul River Valley.

The local allows the observation of distinct reliefs, which present high altitudes related to the morphology of the Itatiaia Alkaline Massif. Its scientific value is connected with the panoramic view of following geomorphological features: i) Campo Belo River Valley and Mantiqueira Mountain Range (Itatiaia Alkaline Massif) (Fig. 2); ii) Dam of Funil hydroelectric power plant, and the Paraíba do Sul River Valley (Fig. 3), both inserted at Continental Rift of Southeastern Brazil; and iii) Bocaina Mountain Range (Fig. 3).

In relation to the possibilities of interpretation, landscape differences may be interpreted based on the distinct lithologies that outcrop in this region.

Rodovia das Flores viewpoint

The site is located on upper part of the INP in UTM coordinates 23 K 528007 / 7526791 with 2173 meters of altitude. The access is performed by BR-485 highway in direction to Rebouças shelter (Fig. 1). The local is a viewpoint with panoramic view of Mantiqueira and Bocaina Mountain Ranges, and Paraíba do Sul River Valley.

Its scientific interest is related to an outlook of mountains relief and Paraíba do Sul River Valley. From the site it is possible to observe: i) Fina Mountain Range, which is a section of the Mantiqueira Mountain Range that

present great highlight because it largely coincides with Passa Quatro Alkaline Massif; ii) Paraíba do Sul River Valley, and iii) Bocaina Mountain Range (Fig. 4).



Figure 2. In the foreground, view of the incised valley of Campo Belo River. At the background view of Mantiqueira Mountain Range (Itatiaia Alkaline Massif)



Figure 3. View of the dam of the Funil hydroelectric power plant and the Paraíba do Sul River Valley, in background Bocaina Mountain Range



Figure 4. In the foreground view of Mantiqueira Mountain Range (Itatiaia Alkaline Massif), at the background view of Fina Mountain Range (Passa Quatro Alkaline Massif), Paraíba do Sul River Valley and Bocaina Mountain Range

The possibilities of interpretation allow the relationship between both alkaline massifs (Itatiaia and Passa Quatro). Besides that, it is possible to approach the position of the site with the Bocaina Mountain Range and the Continental Rift of Southeastern Brazil.

4 Quantitative assessment of potential use

4.1 Methods

The quantitative assessment consists in assigning values for each criterion (scientific, educational and tourism

value, and degradation risk). The quantification of geosites gets important due to the impossibility of applying conservation measures to all the elements of geodiversity in Brilha (2005).

The evaluation of scientific value, potential educational and tourism uses, and the degradation risk was made using the GEOSSIT platform according to Rocha et al (2016), developed by the Geological Survey of Brazil (CPRM). The platform was initially structured on the basis on Brilha (2005) and Garcia-Cortés and Urquí (2009) methods. Recently, it was readjusted and currently adopts the methods and concepts described in Brilha (2016), adapted to the Brazilian reality.

The quantitative assessment of scientific value (SV) is performed with base in these criteria and weights: representativeness (30); key locality (20); scientific knowledge (5); integrity (15); geological diversity (5); rarity (15); and use limitations (10). The result is used for defining if a site of geological interest is classified as geosite, which have geological interest with high scientific value (value ≥ 200) or geodiversity site, which have as main values the educational and/or tourism interests (value < 200).

The evaluation of potential educational use (PEU) utilizes the following criteria and weights: vulnerability (10); accessibility (10); use limitations (5); safety (10); logistics (5); density of population (5); association with other values (5); scenery (5); uniqueness (5); observation conditions (10); didactic potential (20); and geological diversity (10). The assessment of potential tourism use (PTU) applies these criteria and weights: vulnerability (10); accessibility (10); use limitations (5); safety (10); logistics (5); density of population (5); association with other values (5); scenery (15); uniqueness (10); observation conditions (5); interpretative potential (10); economic level (5); and proximity of recreational areas (5).

The quantitative assessment of degradation risk (DR) aims to rank the sites in relation to priority of geoconservation strategies futures. Evaluation of DR takes into accounts the following criteria and weights: deterioration of geological elements (35); proximity to areas/activities with potential to cause degradation (20); legal protection (20); accessibility (15); and density of population (10).

Each criterion may be evaluated with a value among 0 and 4 points. The final value of each geosite is obtained based on the sum of all criteria with their respective weights, which final value ranging from 0 to 400 points. Based on this value, the degradation risk is classified as low (<200), moderate (201-300) or high (301-400).

4.2 Quantitative assessment results

The quantification results of SV, PEU, PTU, and DR of the sites of geological interest Último Adeus and Rodovia das Flores viewpoints are presented in Table 1.

In relation to scientific value, the Último Adeus Viewpoint achieved higher worth, therefore, was classified as geosite; on the other hand, the Rodovia das Flores viewpoint obtained lower value and, consequently, was categorized as geodiversity site. Regarding their potential educational and tourism uses, both have reached at least

250 points, therefore, present national relevance, whereas the values are low for degradation risk.

Table 1. Quantitative evaluation of the scientific value, potential educational and tourism uses, and degradation risk

Site	Scientific Value	Potential Educational Use	Potential Tourism Use	Degradation risk
Último Adeus Viewpoint	275	320	315	155
Rodovia das Flores Viewpoint	165	260	250	135

5 Discussion

Besides SV, the geosite Último Adeus viewpoint achieved the highest PEU and PTU values, which is justified due to its characteristics and surroundings that allows its use by students and tourists. The main criteria that contributed to high score were accessibility, safety, scenery and observation conditions. In relation to these criteria, the geosite is located less than 100 meters from a paved road; presents security infrastructure and rescue services at least 10 km close; is used as a tourism destination in local campaigns; and geological elements are observed in good conditions.

In relation to DR value, the viewpoint Último Adeus is more susceptible than the Rodovia das Flores due to accessibility and density of population. The access to Último Adeus viewpoint is done by asphalted road while the Rodovia das Flores viewpoint through gravel road, moreover, the first site is located on municipality with more inhabitants/km² than the second one. Nevertheless, both presented low degradation risk.

The sites have as main interest the geomorphological features. According to Rodrigues (2013), geomorphological viewpoints are privileged sites for raising public awareness by their aesthetic value, good visibility, magnitude and combination with other heritage sites. For Pereira (2006) the geomorphological heritage consists in the component of geological heritage most noticeable of the population, due to size, configuration and their use potentiality by human activities. Therefore, besides conserving these places, they must be used for dissemination of geoheritage.

The outcomes of the quantification reinforce the approach given by Pereira (2006) and Rodrigues (2013) concerning the importance of viewpoint geosites for raising the dissemination of concepts about geodiversity and geoconservation.

5.1 Possibilities and challenges for educative proposals

The identification and evaluation of these two sites of geological interest in INP confronted the idea that mountain protected areas can only be used for climbers, hiker, and trekking experts. The use of sites with accessibility possesses many advantages, for example, the sites may be used by children in environmental studies; by disabilities people (especially physical limitations) for understanding the evolution Earth; by elderly people and anyone who

wants to learn more about the local geodiversity. Worth mentioning that, a lot of these people only can visit places with access by automotive vehicles

Beyond easy access, the sites of geological interest have presented exceptional characteristics that can contribute to educational and tourism use. Nevertheless, both require some security infrastructures to ensure their public adequate use such as fences, handrails, parapet, and parking for more cars.

In relation to current use, the Último Adeus viewpoint is widely utilized for tourism activities, has road sign and security infrastructures, which facilitates its use for any public. However, due to the limited size, large groups should not utilize it. On the other hand, the Rodovia das Flores viewpoint occasionally is used for tourism purposes; it does not possess road sign or any security infrastructures. Due to insecurity, the viewpoint may cause accident owing to their susceptibilities. Although both geosites include high educational potential, currently none they have any educational activity in progress.

According to Brilha (2016), the geosites, with the most relevance and less degradation risk, must be submitted to promotion strategies. Protected areas stand out as places on education and interpretation activities should be developed, either in the formal or non-formal education actions.

In INP both educational actions may be developed. Regarding formal education, this protected area has already been utilizing in the field trip of several Brazilian universities, mainly in the Geology, Geography and Biology courses in ICMBIO (2013). Moreover, it is already used to environmental studies by elementary and secondary schools of the neighbouring municipalities of the area. The use of the sites of geological interest by the students may contribute to increasing their geoscientific knowledge. For this, study materials, games, and the virtual tour be able to be developed to contribute to disseminating of geological aspects this protected area.

In relation to non-formal education, activities developed in protected areas stand out those carried out through interpretive trails, interpretive centre, guided tours, courses, etc. According to Migón and Pijet-Migón (2017), interpretation facilities such as leaflets, geotourist guidebooks and mobile applications are excellent ways to promote geosites regarding educational and tourism uses. However, they often are expensive.

Based on the reality of protected area, with highlight sites studied, the following interpretation facilities be able to be easily implemented:

- i. Leaflets are already distributed by Itatiaia National Park therefore, they could be readjusted to include Geoscientific information;
- ii. Geosites promotion through digital media such as interpretative points in website www.wikiloc.com, games and virtual tour on the INP website;
- iii. Interpretative panels could be installed to increase the dissemination, and interpretation of geodiversity for self-guided visitors or guided visits (Rodrigues, 2013);

- iv. Increase the geodiversity interpretation through the additional information about the sites of geological interests in the visitor centre of protected area;
- v. Install road sign indicating the location of the main geosites of INP;
- vi. Geotourism guidebooks could be sold or made available on the protected area website;
- vii. Complementary courses on geodiversity could be applied to environmental monitors in Garcia et al. (2016) for providing a solid knowledge about the abiotic elements for them. From this knowledge, they can add these pieces of information to environmental education activities.

These measures of promotion and interpretation of sites and the protected area as a whole become educational proposals quite suitable, which both in relation to geoscientific knowledge and to awareness-raising about the importance of geoconservation.

6 Final remarks

The sites studied shown that both possess easy access and viewpoint typology. The set these characteristics is essential for being broadly used for any public.

The viewpoint geosites consist in a quite attractive typology to the public. Their panoramic views contribute to awareness raising in relation to the necessity of geoconservation at the same time in which are suitable locals for educational and interpretative actions.

The outcomes showed that one was classified as geosites and other as geodiversity site. Even with different classification, the sites achieved high scores based on potential educational and tourism and both were classified with national importance. Moreover, both sites obtained low value regarding degradation risk, for this reason, they may be established measures aiming their promotion.

It should be noted that the low values of Rodovia das Flores viewpoint in relation to potential educational and tourism are related to the characteristics that can be modified, such as accessibility; use limitations, safety, logistics, scenery and observation conditions, making it possible to increase these values if the necessary measures are taken.

Based on the degradation risk results, the data indicate that both geosites may be promoted regarding educational and tourism uses due to low degradation risk.

The interpretation facilities for formal and non-formal education was proposed and involve the development and insertion of geoscientific information in leaflets, digital media, interpretative panels, visitor centre, road sign, geotourism guidebooks and complementary courses on geodiversity.

Finally, the easy access plays an important role in the use these sites to any public. Therefore, the high scores of potential educative and tourism reinforce the necessity of using these geosites for educational actions. Further, the application the interpretative measures may be contribute

to the interpretation, promotion, dissemination and conservation the geodiversity elements in these sites and in the protected area as a whole.

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